Measurement of signal crosstalk in prototype Digital Jumper Cables

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21 May 2002

14.70

GND

GND
CLK
/CLK
GND

DBOV
/DBOV
D0
/D0
D1
/D1
D2
/D2
D3
/D3
D4
/D4

DVDD

D5
/D5
D6
/D6
D7
/D7
PRI OUT
/PRI OUT
SEN GND
VCAL
TEMP 1
TEMP 2

AVDD

SEN AVDD
SEN DVDD
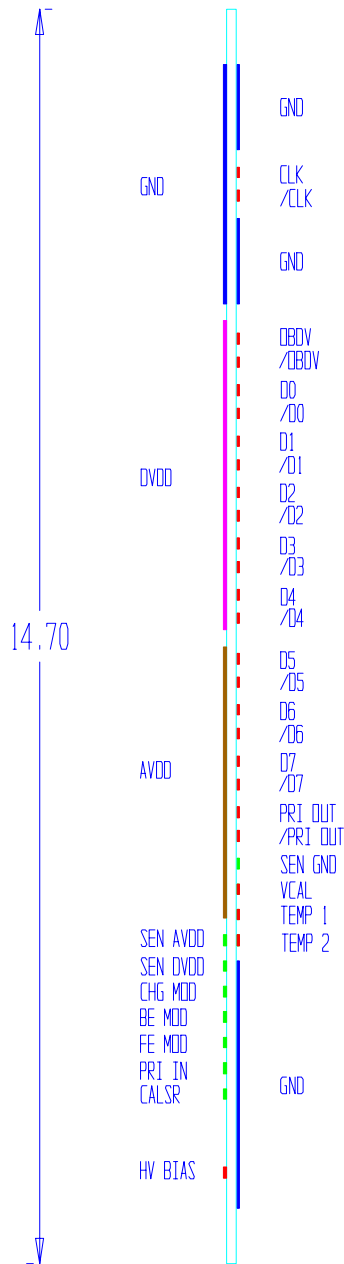CHG MOD
BE MOD
FE MOD
PRI IN
CALSR

GND

HV BIAS

Fig. 1: Cross section of Digital Jumper Cable.

Introduction. Signal lines, 0.125 mm wide, in the Run2b Digital Jumper Cables are quite closely-spaced, with only 0.200 mm of gap separating lines of different differential pairs, and only 0.175 mm of gap between single-ended signal lines. Only the CLK, /CLK pair is relatively well-isolated with buffering ground strips ~ 1 mm wide (Fig. 1). The possibility of crosstalk between signals is thus a legitimate concern.

However, these measurements show that crosstalk is not a serious problem.

Test setups. The test setups for measuring crosstalk on single-ended and differential lines are sketched in Fig. 2. Two 50-cm prototype flex cables were connected end-to-end by a small "daisy-chain board" to make a cable effectively 100 cm long. "Input" and "output" boards brought all pins on the flex cable AVX connectors to 0.1" headers for convenient access. Single TTL signals or normal-inverted TTL signal pairs were connected to the input board with ~40 nsec of RG58 50 Ω coax and resistors to match the measured flex cable impedance (61 Ω for single-ended lines, 107 Ω between differential pairs). A step-function input pulse shape was used.

Measurements of transmitted signal and of crosstalk were made at the unterminated output board with one or two 1 GHz active probes (Tektronix P6243). In the case of differential signals, the "A-B" scope function was used to subtract signals.

Lines being checked for crosstalk were terminated at the <u>input</u> board to simulate the twisted-pair input lines: by 107 Ω to ground for single-ended lines, and by 107 Ω between lines for differential pairs.

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Fig. 2a: Test setup for measuring crosstalk between single-ended signals. Lines being inspected for crosstalk were terminated in 107 Ω to ground at the input board. All signals were open-ended at the output board.

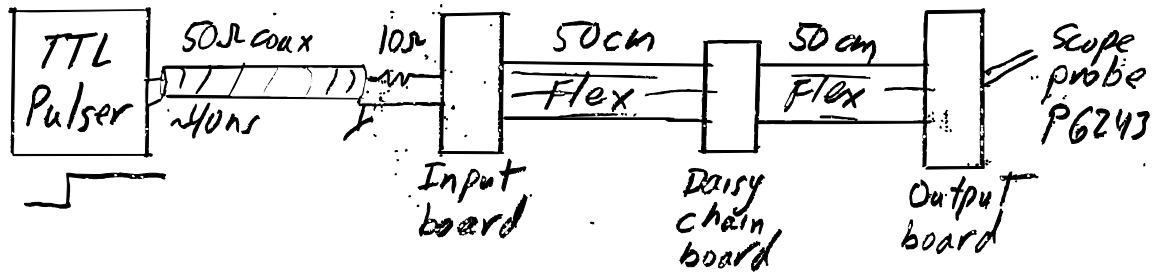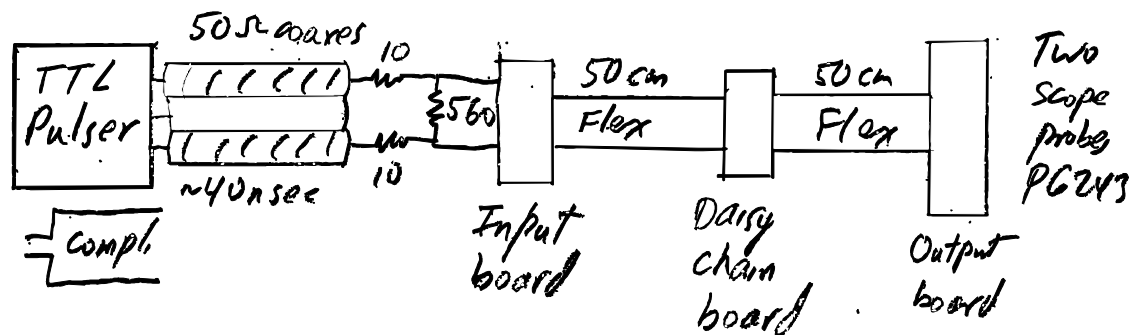**Fig. 2b:** Test setup for measuring crosstalk between differential signals. Lines being inspected for crosstalk were terminated in 107 Ω between lines at the input board. All signals were open-ended at the output board.

Crosstalk between single-ended lines. A TTL step was fed into the BE_MOD line, and crosstalk was inspected at the open-ended output board in the nearest neighbors FE_MOD and CHG_MOD and in the next-nearest neighbor PRI_IN (see Fig. 1). In all cases, the neighbor lines were terminated with 107 Ω to ground at the input board. Results are shown in Figs. 3 and 4. Crosstalk signals are ~20 nsec transients, at worst 13% of the direct signal for nearest neighbors and 6% for next-nearest neighbors. This is similar to the behavior of the Run 2a low-mass cables.
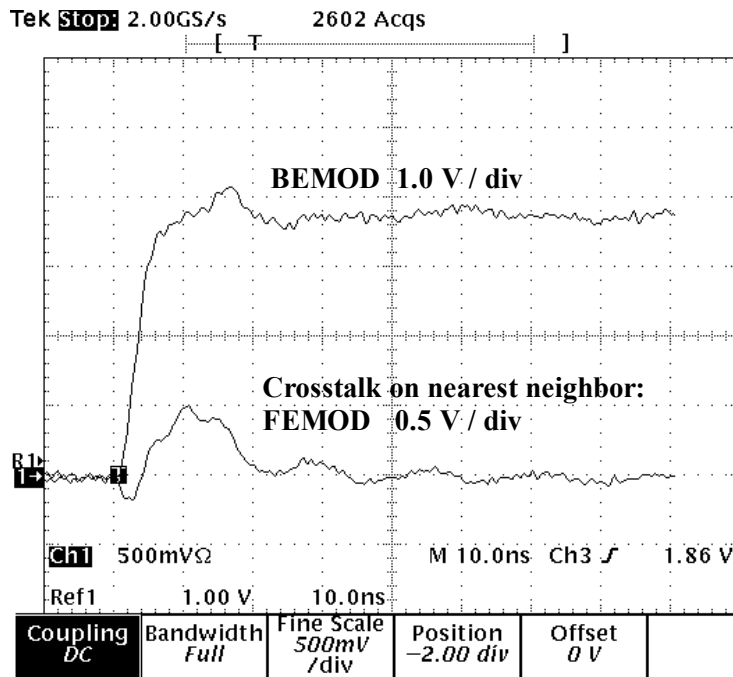

Fig. 3. Crosstalk on a nearest-neighbor single-ended line. The induced signal on the other nearest neighbor to BE_MOD (CHG_MOD) looks identical to that on FE_MOD.

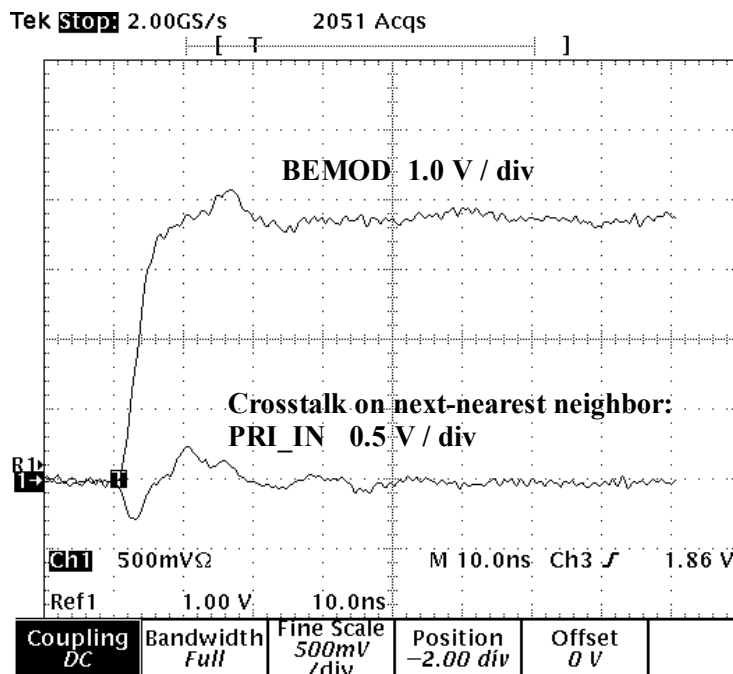Crosstalk is at worst 13% of the direct signal.

Fig. 4. Crosstalk on a next-to-nearest neighbor single-ended line (PRI_IN) when the signal is applied to the BE_MOD line.

Crosstalk is at worst 6% of the direct signal.

Crosstalk from the clock lines. For this test, a differential TTL pair was connected to the CLK, /CLK lines at the input board (Fig. 2b), and the A-B scope function was used to subtract the signals from the two probes at the open-ended output board. Crosstalk was looked for (Fig. 5) on the nearest differential pair to the clock lines (OBDV, /OBDV) and on the nearest single-ended line (CHG_MOD). In all cases, the neighbor lines were terminated with 107 Ω. No crosstalk signal is seen; any effect is less than 3% of the direct signal.
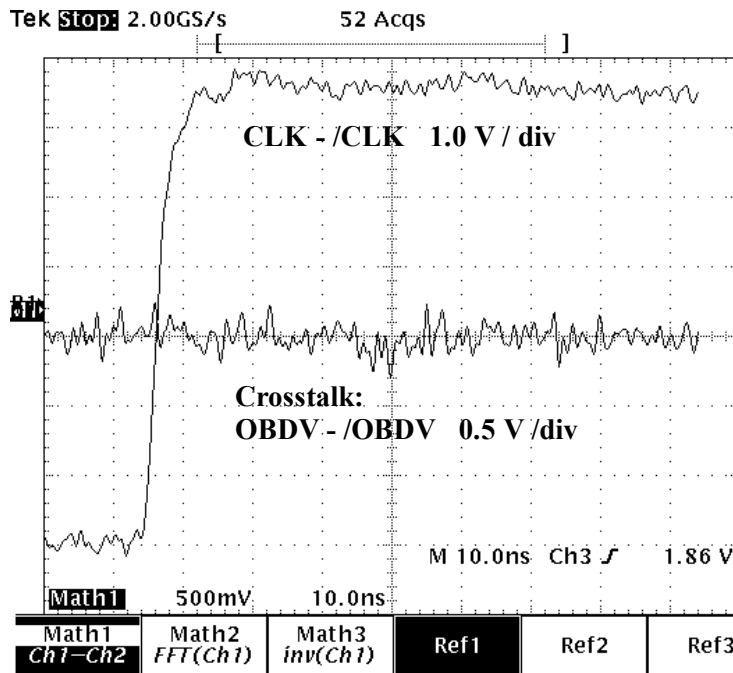

Fig. 5. Absence of crosstalk on the nearest differential pair (OBDV, /OBDV) to the clock lines.

Any effect, if present, is less than 3%.

Crosstalk between the clock lines and the nearest single-ended line is also not seen.

Crosstalk between other diferential lines. A differential TTL pair was connected to the D1, /D1 lines and crosstalk was looked for at the open-ended output board on the nearest neighbor pair D2, /D2 and on the next-nearest neighbor pair D3, /D3. In all cases, the neighbor lines were terminated with 107 Ω between differential lines at the input board. Results are shown in Figs. 6 and 7.

The crosstalk on the nearest-neighbor pair is inverted and about 11% of the direct signal. Crosstalk on the next-nearest neighbor is undetectable; any effect is less than 3%.
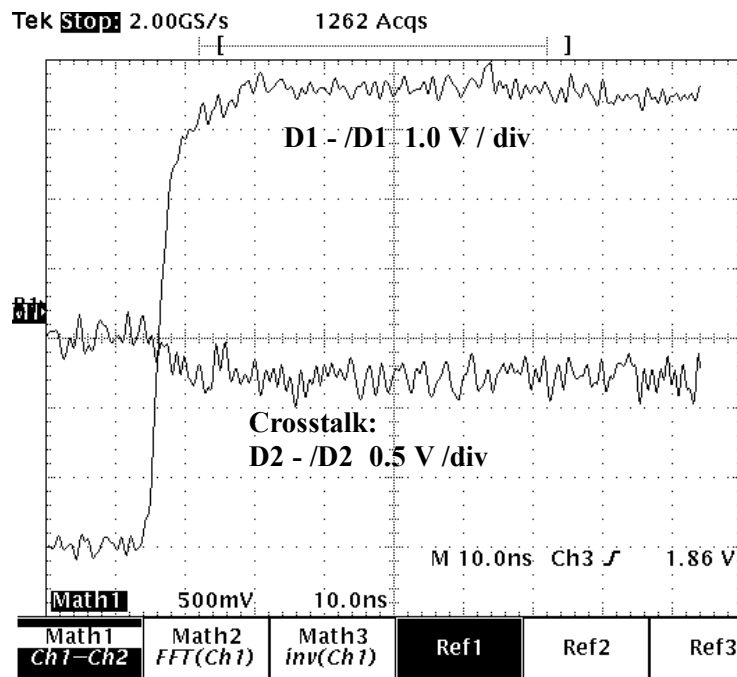
Fig. 6: Crosstalk on nearest-neighbor differential data line. Input signal on D1, /D1, look on D2, /D2.

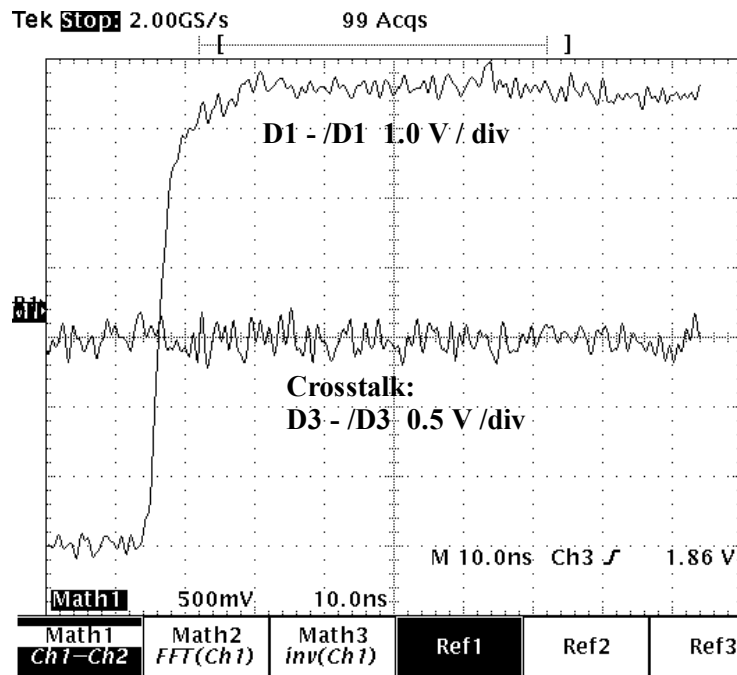Crosstalk from a step is an inverted step about 11% of the direct signal.

Fig. 7: Crosstalk on next-nearest-neighbor differential data line. Input signal on D1, /D1, look on D3, /D3.

Crosstalk is less than 3% of the direct signal.

Conclusion. Signal crosstalk is not a significant problem.